ON THE NERVOUS LESIONS PRODUCED BY LEAD-POISONING.

(From the Pathological Laboratory of the Owens College.)

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THOUGH cases of lead-poisoning are of frequent occurrence, up to the year 1880, when Dr. Moritz¹ published his paper on Lead Palsy, only seventeen cases had been placed on record in which a satisfactory post-mortem search for the cause of the paralysis had been made; Dr. Moritz's case brought the number up to eighteen.² Since 1880 two other cases have been published. One by Oeller,³ who found the following changes in the nerves and spinal cord of a man, aged 40, who had worked in lead for a year and three months, and who had suffered from paralysis of the extensor muscles of the wrist and fingers of the interossei of the hand, and of the muscles of the thenar eminence.

Spinal Cord.—Small hæmorrhages were found in the middle of the anterior horns, and at the junction of the anterior and posterior horns, in the anterior longitudinal fissure round the large blood-vessels, and also in the white substance of the cord. In the cervical enlargement, from the fifth to the eighth cervical nerves, small spots of softening were found. Spots of softening were also found in the middle of the anterior horns and in the anterior part of the posterior horns. In these positions the ganglion cells were small, atrophied, highly-pigmented, homogeneous, hyaline, and devoid of processes;

¹ 'Journal of Anatomy and Physiology,' 1880.

² Lancereaux, 3; Gombault, 1; Westphal, 1; Tiburtius, 1; Friedländer, 1; Ollivier, 1; Zunker, 1; Eisenlohr, 1; Vulpian, 1; Déjérine, 5; Monakow, 1; Moritz, 1.

³ Oeller, Thesis, Munich, 1883.

they stained badly, and no nuclei were visible in them. Others of the ganglion cells contained large vacuoles. There was a number of spider cells.

The white substance of the cord was only affected in a subordinate degree. Some of the fibres of the musculo-spiral nerve were atrophied, and there were the usual changes in the muscle. Oeller concludes, that the central changes were the primary and essential part, and that the hæmorrhages, following on the general arterial degeneration, were the cause of the softening.

The second case is recorded by Duplaix.¹ The patient was a man, aged 47. He had been a painter for many years, and had been very feeble for a year. There was no trace of syphilis or alcoholism.

The patient noticed, when the feebleness first affected him, that his limbs rapidly lost flesh, and finally the emaciation extended to his face and trunk. The muscular feebleness increased, and at last he was unable to leave his bed. Sensation was normal. He was affected with purpura, œdema of the lungs set in, and death rapidly followed. The post-mortem showed granular kidneys, a small heart, and atrophied muscles.

The spinal cord and the nerves were carefully examined, marked changes being found in both.

Spinal Cord.—The neuroglia was increased in amount, forming bands of tissue enclosing spaces filled with nerve-tubes.

The nerve-tubes were also separated by fine fibrils of connective tissue and many round nuclei. The vessels throughout the whole cord were sclerosed and surrounded by a dense connective tissue.

The nerve-cells in the anterior and posterior horns were unchanged. In the anterior roots, distinct changes were discovered in the structure of the nerve-fibres. The alteration did not extend over the whole length of a fibre, the affected portion being continuous at either end, with an absolutely healthy portion.

The disease usually extended over three or four internodal

¹ Duplaix, 'Arch. Gén. de Méd. 1883,' vol. 2.

segments. Rarely was one segment affected alone. In fact, the changes were those described by M. Gombault, under the name "phase of restitution."

The myelin sheath was everywhere present, but some portions of the fibres were thinner than others, the diminution in volume affecting both the axis-cylinder and the myelin sheath. Nerve-fibres were also seen exhibiting swelling of the white sheath, and also of the axis-cylinder, and in some places there were empty tubes, the nuclei of which had proliferated. The posterior roots were healthy.

The nerves showed both degeneration and restitution. The muscular fibres had atrophied, and their nuclei had proliferated.

The following case was admitted into the Manchester Royal Infirmary, under the care of Dr. Leech, whom I have to thank for kindly permitting me to make use of it, in December 1882. The patient, J. C., a man, aged 30, had been a painter for fourteen years, but for three years before his admission he had nominally been a cabinet-maker, though he still occasionally did a little painting.

He had his first attack of "drop wrist" in the summer of 1877; it continued through the winter, but he recovered in the following spring. Every winter after his first illness, the attack returned and laid him up until the spring.

He was troubled with frequent micturition, but had never had colic or cramps.

The muscles of both forearms were very much atrophied, the extensors of the wrists and fingers were completely paralysed, while the flexors retained a fair amount of power. The muscles of the thenar and hypothenar eminences were also atrophied, and the patient could not oppose his thumbs. He could pronate, but could only partially supinate both forearms. The peroneus brevis and longus muscles on the left side were atrophied and paralysed, and those of the right side were affected with paresis. All the atrophied muscles showed the reaction of degeneration when tested with electricity.

The patient was treated with iodide of potassium, and the interrupted and continuous currents were applied to the affected muscles. He gradually improved, the atrophied muscles

increased in size, and to a certain extent regained their power. He was dismissed in March, 1883, very much improved.

He was readmitted in June 1884, suffering from œdema of the lower extremities, and from effusion into both pleuræ; his muscular system was almost in the same state that it was in when he left the hospital in 1883. His urine contained albumen and coarsely granular casts. He improved under treatment, and left the hospital in March; but the œdema returned, and he was readmitted at the end of the same month. Ascites developed, and he died on the 14th of August, 1884.

A post-mortem examination was obtained, and the spinal cord, together with some portions of the musculo-spiral nerves, were removed, but, unfortunately, none of the atrophied muscle was kept. I examined the cord carefully, by means of sections taken from the various regions, and stained some with carmine alone, others with osmic acid and carmine.

There was no visible abnormal change in any part of the nervous matter. The nerve-tubes in the white columns were intact; there was no swelling of the axis-cylinder, or degeneration of the myelin.

The nerve-cells in the grey columns did not appear to be reduced in number, or to be at all atrophied. Their processes were well marked, and their nuclei distinct.

There was no marked increase of the neuroglia.

There was well-marked hyaline degeneration of the walls of the arteries, both in the grey and white substance of the cord. The degeneration affected, principally, the middle and outer coats of the vessels. The cellular elements were swollen, their outlines in many places being lost; the nuclei were not visible, and they did not stain with either carmine or logwood.

The musculo-spiral nerve was examined by means of transverse and longitudinal sections, and preparations were also made by teasing out the fibres with needles. The sections and teased-out specimens were stained with carmine and osmic acid.

The axis-cylinders were everywhere distinct; there was no fragmentation of the myelin sheaths, except in a few instances, where the breaking up was evidently due to the method of preparation. There was no proliferation of the nuclei of the

sheaths, nor was there any increase of the surrounding connective tissue. The walls of the small arteries in the nerve-sheaths had undergone a hyaline change similar to that noticed in the arteries of the cord. The radial nerve was not kept.

The kidneys were small, the capsule was adherent, and when separated carried with it portions of the kidney substance.

Microscopically they presented, in a well-marked form, the changes of advanced cirrhosis. The newly formed connective tissue was most abundant and most dense round the interlobular arteries.

When lead-poisoning first attracted observation, attention was chiefly directed to the affection of the extensor muscles, and Gusserow¹ attempted to explain the paralysis by supposing a particular affinity of lead for the muscles; but this hypothesis was completely destroyed when Heubel² demonstrated the fact, that the muscles contained less lead than the bones, kidneys, liver, brain or spinal cord; and some researches undertaken by Bernhardt,³ with a view of discovering the relative amounts of lead contained in the paralysed extensor and the normal supinator muscles, gave negative results.

No one would undertake such investigations now, for it is well known that the action of lead, as a poison, is not local but general; the general effect being evidenced by the various encephalic symptoms due to lead, by optic neuritis, amaurosis, hemianæsthesia, and other anæsthesiæ of irregular distribution; tremors, and paralysis, not limited to one set of muscles, but affecting the muscles of the body generally;⁴ colic, cramps, and affections of the kidneys.

Though the paralysis produced by lead is by no means limited to the extensor muscles, still they are generally the first to show definite changes. The researches of Onimus,⁵ carried out on the muscles and nerves after death, point to an

¹ Virchow's 'Archiv,' 1881.

² 'Path. u. Symptom. d. Chem. Bleilähmungen,' 1871.

³ 'Archiv für Psychiatrie,' iv., p. 616.

⁴ Buzzard, 'BRAIN,' No. 1. Duplaix, 'Archiv. Gén. de Méd.'

⁵ "On the Excitability of the Nerves and Muscles after Death" ('Journal de l'Anatomic,' No. 6, 1880).

explanation of this fact. He found that the extensor muscles and nerves lost their excitability before the flexor muscles and nerves, and those of the upper extremity before those of the lower. Again, the fact, first pointed out by Dr. Semon, is now well recognised, that the abductor muscles of the larynx always become paralysed before the adductors, in central or peripheral disease of its nerves. These observations point to the conclusion, that the extensor and abductor muscles and nerves possess a less power of vital resistance than the flexor muscles and nerves, and consequently, under the action of a general poison, they will be the first to succumb.

Concerning the lesion which is the direct cause of the paralysis three views are at present held.

Friedländer¹ holds that the primary change is a myositis, induced by the lead, and that this is followed by a neuritis, which ascends to the cord.

The second hypothesis, supported by Zunker, Leyden and Ferrier, is that the primary change is a peripheral neuritis. Lastly, Remak, Vulpian and Déjérine believe that lead produces a poliomyelitis anterior.

So far the results of the published cases appear to favour the second view. We know that lead acts injuriously on the nerve-cells in the brain, producing in many cases serious symptoms, and, not rarely, death. There is no reason, therefore, why it should not have a direct action on the nerve-cells of the cord. Further, a poison may seriously interfere with the function of a nerve-cell, and yet, at first, produce no visible change in it; alcohol and strychnia act in this manner.² But, while the nerve-centres are subjected to the direct influence of the poison, and must also be injuriously affected by the general arterial degeneration, the nerve-fibres are at a still greater disadvantage, for, besides being directly acted upon by the lead, and suffering from the arterial degeneration, they will also be affected by the loss of the trophic influence which, in a state of health, the nerve-cells exert over them.

Thus it appears probable, that as the nerves suffer in a double manner, as compared with their centres in the cord,

¹ Virchow's 'Archiv,' 1878.

² Cf. paper by De Watteville, "The pathogeny of lead paralysis," 'Lancet,' 1880.

alterations will proceed more rapidly in them than in their centres, and consequently visible changes will, as a general rule, be first recognised either in the nerve-trunks, or their peripheral terminations. So far the published cases support this view, for in 11 out of the 21 cases, changes were found only in the nerves and muscles.¹ In the case I have reported above, no changes were discovered either in the cord or the trunk of the musculo-spiral, though it is very probable that some degeneration would have been found in the radial nerve or its peripheral terminations, had they been kept.

In 4 cases, degeneration was found both in the nerves and the anterior nerve-roots, the cord not being affected;² while in 5 cases the cord, as well as the nerves and their roots, was affected:³ and in one of these, namely that described by Zunker, the changes in the cord, which consisted of localised spots of softening, did not correspond to the centres, from which the diseased nerves sprang. It is to be noted, further, that, in all the cases in which visible alterations were discovered in the cord, the symptoms had been present for a long period of time.

Finally, I have to thank Dr. Dreschfeld for his kind assistance in the examination of the microscopical specimens.

¹ Lancereaux, 2; Gombault, 1; Westphal, 1; Tiburtius, 1; Ollivier, 1; Eisenlohr, 1; Déjérine, 3; Moritz, 1.

² Friedländer, 1; Déjérine, 2; Duplaix, 1,

³ Lancereaux, 1; Zunker, 1; Vulpian, 1; Monakow 1; Oeller, 1.